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Reaction of Familial Contacts to Scarlet Fever Infection*

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VARIOUS epidemiological aspects of scarlet fever have been reported from observations of a relatively large group of patients isolated at the Herman Kiefer Hospital, Detroit. Studies limited to hospital patients fail to give a comprehensive idea of the epidemiological problems associated with this disease. Even in large cities the majority of persons with scarlet fever are not isolated at a hospital. Conditions affecting the transmission and control of the infection differ considerably when the patient remains at home. A great part of the information about the clinical nature of scarlet fever, and much of its epidemiological behavior have been determined by hospital studies, because of the greater ease with which precise and continued observations can be made, the facilities for laboratory examinations, the better opportunity for control of disturbing factors, and the generally better available records. Information about a group of patients isolated at home, and studied as nearly as possible with equal thoroughness and with the same methods, offers the possibility of contribution to the broader problem.

Influenced by these considerations, an epidemiological survey of scarlet fever under home conditions was started in the summer of 1931 among an urban population of Detroit. The observations have extended through 3 years, and are concerned only with ordinary endemic scarlet fever, not with a sharp outbreak of the disease. The information from such a study cannot of course be given universal interpretation. In rural communities, for example, environmental conditions are different; there is variation in the multiplicity of contacts, in response to the infection, and assuredly in the opportunity for continued transmission of the infectious agent. Nevertheless, a more exact appreciation of the epidemiological problems in urban communities can in all likelihood be obtained through comparison of this information with the be-

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havior of the disease in a group of hospital patients, studied by essentially the same methods.

A variety of interests have naturally been involved in this field study of scarlet fever. Information was desired on the reservoirs of infection during the time when scarlet fever was at a low level in the community, and on the factors involved in school epidemics, their origin, development, and extent. General opinion has catalogued scarlet fever as a disease whose transmission is related more to carriers than to contact with actual cases. A quantitative evaluation was desired. An answer has been sought as to how scarlet fever is introduced into families; and an attempt made to determine the effectiveness of various administrative procedures for the control of the disease, particularly isolation. The material in this report is restricted to the reaction of the familial contacts in homes invaded by scarlet fever infection.

METHOD

The area selected for study represents one of the sanitary districts of Detroit. The population, 100,000, was sufficient to permit adequate data. The district is residential, and the population principally white. A very small negro population is included, but scarlet fever occurred in only 2 colored families in the course of these observations. About one-third to one-half of the population is in average economic circumstances, with living conditions representative of the usual residential area in Detroit. The area also has two relatively poor neighborhoods, one with a population principally of Italian origin, the other native born; and two better than average residential districts, one of which is a university neighborhood.

Field studies were started in the summer of 1931 and continued uninterruptedly until the summer of 1934. An epidemiological investigation was made of 1,097 families in which cases of scarlet fever were reported. The primary cases of 732 families were isolated at home, and 365 at the hospital for communicable diseases.

This study was definitely independent of the work of the regular staff of the Health Department. They made their usual investigations and effected their usual recommendations without influence. No attempt was made to correct deficiencies in control that we might discover independently, such as an unrecognized and unreported infection. The greater benefit was thought to rest in determining the behavior of scarlet fever infection under usual and ordinary circumstances.

The first visit to the home was principally devoted to obtaining information about the source of the infection. Schoolmates, playmates, and all other persons involved were later investigated. Record was made of the age, past history of scarlet fever, and number of familial contacts. The Dick test for immunity to scarlet fever was made at this time, and cultures were prepared from swabbings of the nose and throat, to be examined for the presence of hemolytic streptococci.

A second visit was made the following day. The results of the Dick test were determined, and inquiry was made regarding other illness and possible extension of the infection among members of the family. Subsequently, visits were made at the end of the first and second weeks. The purpose was to determine if others of the family had contracted scarlet fever, or had been ill with any acute infection, and for the original patient to determine the course of the disease, and the presence or absence of complications.

The fifth visit was made at the end of 4 weeks, about the time that isolation was terminated, in order to determine the clinical condition of the patient, and particularly the factors which might

account for transmission of infection after release. Some of the patients had been isolated at the hospital and some at home. A comparison was made of the reaction of contacts after isolation by these two methods.

The next visit was about 8 weeks after the onset of the original infection. The behavior of the contacts in the intervening month was recorded and all of the events in the course of the preceding 2 months were reviewed and summarized. Contacts with an originally positive Dick reaction were retested. Some of those who had reacted negatively were also tested. Cultures were again taken for hemolytic streptococci. The final visit was made the next day to determine the result of the Dick test.

The first and sixth visits were by a physician, the others by one of two specially qualified nurses, carefully trained in epidemiological methods. Special visits to investigate a new case, indeterminate illnesses, or other unusual circumstances were made by the medical epidemiologist.

Every home with a case of scarlet fever was visited, but records are not complete for all. Most of the patients were under the care of private physicians. Before epidemiological investigation was undertaken the approval of the physician was asked, and almost always obtained, but there were exceptions. Because of this procedure, some delay in making the first visit to the home was unavoidable. This was sometimes possible on the same day that the case was reported, but the following day was more usual. Some contacts had by that time already been removed to the home of an adult friend outside of the isolation area. Many times the wage earner had taken other quarters. In rare instances the head of the family refused permission, but one of the encouraging features of the study was the ready coöperation encountered. Occasionally, because of the stress of increased numbers of reported cases during the season of greatest prevalence, epidemiological investigation could not immediately be made. Later, as conditions permitted, this was done, but no investigation made later than 1 week after the first reported case is included in this report.

PAST HISTORY OF FAMILIES WITH SCARLET FEVER

In the course of the 3 year study, scarlet fever occurred in 1,097 families in the area studied, with at least 1 case in each. The number of individuals in these families was 5,352; 2,455 were children less than 15 years of age and 2,897 were adults. The previous occurrence of scarlet fever in this group is shown in Table I. Relatively few (9) of the 670 children less than 5 years of age had previously had scarlet fever. The proportion in the age group 5 to 9 years was distinctly greater, 84 (7 per cent) of 1,194. Of 591 older children, aged 10 to 14 years inclusive, 87 had had scarlet fever, or 14.7 per cent (Table I).

TABLE I

AGE DISTRIBUTION OF INDIVIDUALS IN FAMILIES WHERE SCARLET FEVER OCCURRED, ACCORDING TO HISTORY OF PREVIOUS SCARLET FEVER

Age	No Previous Scarlet Fever	Previous Scarlet Fever	Uncertain about Previous Scarlet Fever	Totals
0- 4 yr.	654	9	7	670
5- 9 "	1,100	84	10	1,194
10-14 "	494	87	10	591
15+"	1,923	688	286	2,897
Totals	4,171	868	313	5,352

The number of adult persons who gave a history of previous scarlet fever was 688 of 2,897 questioned, or 23.7

per cent. The proportion was so unexpectedly great, that a check was made by examining a sample of the records of scarlet fever patients reported in Detroit during the first 6 months of 1934. The frequency of previous scarlet fever among adult contacts was found to be 16.4 per cent. These data were obtained in the course of the usual public health investigation by many different public health nurses. This percentage is also measurably higher than one would have anticipated.

Before scarlet fever entered this group of 1,097 families, 180 of the 2,455 children and 688 of the 2,897 adults had already had scarlet fever.

SCARLET FEVER IN FAMILIES

Knowing the past history of scarlet fever in these family groups, the circumstances are now presented under which scarlet fever subsequently occurred. All of the family groups had at least 1 case of diagnosed and reported scarlet fever. Although the number of families was 1,097, 1,102 cases of scarlet fever are considered to have been primary infections. In 3 families the disease developed simultaneously in 2 persons, and in one instance 3 cases developed on the same day. This accounts for the discrepancy between the number of families and the number of primary cases.

Scarlet fever usually appeared suddenly in an otherwise healthy group (868 families). The source of the infection is not of present interest. In 30 instances, the first reported case was actually not the initial invasion of the household. Some other member of the family group had previously had an acute infection whose identity as scarlet fever was first recognized when the second case developed, the 2 being reported at the same time. The interval between the 2 was always more than 4 days, that being our interpretation of the limit of acceptable reporting. The original infection in 41 other families was an undiagnosed case, determined by epidemiological investigation but never reported by the attending physician. Throughout the isolation period these patients were not restricted from association with contacts.

In this report the term undiagnosed scarlet fever will refer to unrestricted persons with a history of an acute illness compatible with that of scarlet fever, and will indicate actual observation by the epidemiologist of either a scarlatiniform eruption of the skin, or the typical desquamation of scarlet fever.

In a considerable proportion of families (158) an interesting and unsuspected observation was made. An indeterminate illness of the upper respiratory tract in another member of the family had shortly preceded the appearance of scarlet fever. The usual interval between such illnesses and the appearance of scarlet fever was about 1 week, sometimes 3 or 4 days, occasionally 2 weeks. Most of these infections were tonsillitis, although a not inconsiderable number resembled common colds. In subsequent tabulated data, distinction is made between the two. A number were strongly suggestive of scarlatinal infections, but our requirements for classifying an infection as undiagnosed scarlet fever were strict. Two examples of such questionable infections are in point.

Case 1—A woman, aged 34, had fever, sore throat, and headache. She noticed no eruption of the skin. Twelve days later a daughter, aged 4 years, developed scarlet fever. The previous illness of the mother was recorded at this time. Physical examination showed suggestive but indefinite desquamation, limited to the ends of the fingers. Her illness was classed as tonsillitis. The child had had no known exposure to scarlet fever.

Case 2—A boy, aged 5, had fever, vomited, did not complain of sore throat, had a discharging nose, and when seen 3 days later gave the impression of having a slight subcuticular flush, perhaps compatible with a

disappearing rash, but this was decidedly indefinite. The mother stated that she had noticed no rash. The tongue appeared normal. Cultures of the throat contained hemolytic streptococci. Desquamation was never observed. The illness was classed as an upper respiratory infection. The mother developed classical scarlet fever 3 days after the onset of the boy's illness.

Often such illnesses were not limited to a single member of the family; 206 individuals were involved in the 158 families in which this circumstance was noted. In 3 of the families the succession of events was a nonspecific illness, then an undiagnosed case of scarlet fever, and finally recognized scarlet fever (Table II).

TABLE II
ILLNESSES IN FAMILIES BEFORE RECOGNITION OF SCARLET FEVER

	Number of Families	Number of Persons Ill
No illness	868	—
Scarlet fever, unrecognized until second case	30	41
Scarlet fever, undiagnosed	41	43
Upper respiratory disease	158	206
—with hemolytic streptococci	70	78
—without hemolytic streptococci	54	78
—not cultured	34	50

In connection with these illnesses which preceded scarlet fever there are two points of interest: (1) Were they streptococcus infections? (2) Are they to be considered the means by which scarlet fever was introduced into the family? The idea that scarlet fever may exist in larval form is of course not new, nor has the possibility been neglected that this is one of the ways in which it is transmitted. Many reports are on record. Information is lacking in regard to the quantitative importance.

Cultures from the nose and throat of persons with antecedent illnesses were made at the time the first case of scarlet fever was reported. It will be recalled that this was shortly after the onset of the reported case. It was manifestly impossible to know their nature earlier, because it was the reporting of scarlet fever which initiated the investigation. Cultures were taken from 156 persons; hemolytic streptococci were present in about half. Streptococcus infection is suggested. It is possible also that these patients may have developed, a carrier condition through contact with the patient with scarlet fever, and that the original illness was not of streptococcal nature.

Whatever the interpretation, individuals with these illnesses preceding scarlet fever had the highest hemolytic streptococcus rate (50 per cent) of any group of contacts. Other members of the same families but without an upper respiratory infection had a rate of 23 per cent. Members of families free from infections of this kind had the lowest rate, 17 per cent (Table III).

Contributing pertinently to the interpretation of these illnesses is the fact that people with such antecedent upper respiratory infections did not develop scarlet fever with anywhere near the same frequency as did contacts in general (ratio 1:3), despite the fact that hemolytic streptococcus invasion of the upper respiratory tract was more frequent. Many unusual circumstances determined by epidemiological investigations contributed strongly to the belief that it was by this means that scarlet fever was introduced into families. Numerous interesting examples could be cited, but the following are typical:

TABLE III

HEMOLYTIC STREPTOCOCCUS CARRIERS AMONG CONTACTS TO PATIENTS WITH SCARLET FEVER

	Hemolytic Streptococcus Cultures			
	Positive		Negative	
	No.	%	No.	%
Individuals with upper respiratory infections preceding scarlet fever	78	50.0	78	50.0
Contacts to these	63	23.0	211	77.0
Totals	141	32.8	289	67.2
Contacts to cases where no illness preceded the first case	332	16.8	1,649	83.2

Case 3—One of 2 boys contracted scarlet fever. They were class-mates, friends, and both were 7 years of age. Three days later the second boy had a severe sore throat, fever, and headache, but no eruption and no subsequent desquamation. After another interval of 3 days his brother, aged 9, developed typical scarlet fever. On the same day a 12 year old sister was also acutely ill, had an indefinite eruption, was not considered to have scarlet fever, but later desquamated. On the day following these 2 infections a 15 year old brother developed a sore throat, of much the same nature as the original infection of the 7 year old, without eruption and, as determined by later investigation, without desquamation.

Case 4—An intimate playmate of a boy, aged 8 years, developed an acute sore throat. Whether or not this was the source of the second infection is impossible to determine with exactness. At any rate, 10 days later the second child developed sore throat and after another 11 days, an abscess of a cervical lymph node was incised. The child had no rash at the time of the acute illness and never desquamated. Three days after the gland was incised there were 3 outspoken cases of scarlet fever in the family, affecting children aged 6, 8, and 12 years. The sudden appearance of these 3 cases on the same day indicates an infection from a single source. Two days later another child, aged 3 years, developed scarlet fever, apparently secondary to one of the other 3.

Case 5—Two visitors, a man and wife, were house guests at the home of friends. In the course of their journey, the lady had developed a sore throat, present at the time of their arrival. No rash was noted, nor was there subsequent desquamation. Three days later an adult member of the family developed a sore throat, said to have been of relatively severe nature, but unaccompanied by a rash. Four days later a child, aged 3 years, had typical scarlet fever. Later both the mother and the child desquamated typically. Hemolytic streptococci were demonstrated in cultures from the throats of both visitors, the mother and the child.

The likelihood that such throat infections are many times of scarlatinal nature has long been accepted. Examples like those given are not unique. A quantitative evaluation of such infections as a possible factor in the spread of scarlet fever has not been made. In this experience such nonspecific illnesses preceded scarlet fever in 14.4 per cent of families.

ORIGIN OF SECONDARY CASES

Family contacts exposed to an original case of scarlet fever included 4,250 individuals, of whom 1,446 were children and 2,804 were adults.

The number who thereafter developed recognized and reported scarlet fever was 266. All cases occurred at least 1 day after the original infection and within 2 months. In addition 44 other persons had unrecognized scarlet fever subsequent to the original reported illness in the family and likewise are secondary cases but were never reported. They are to be added to the 266, making in all 310.

How was scarlet fever spread from the original case to a healthy contact? About one-third are attributed to direct contact infection from the original case; that is to say, transmission was from case to case. This was true for 93 of the recognized secondary cases and 11 of those undiagnosed. This interpretation was made only when the interval between cases was less than 1 week. The usual time was 2, 3, or 4 days. This does not eliminate the possibility of carriers, but it is felt that case to case transmission is the most likely interpretation (Table IV).

Another group of secondary cases was considered to have developed through the agency of contact carriers. When this interpretation was made, the original patient had been isolated at least 1 week, and there had been no intermediate cases. A second type of carrier includes persons with intermediate illnesses of the type described as often preceding scarlet fever. Eighteen

TABLE IV

ORIGIN OF SECONDARY CASES

Sources of secondary cases	Diagnosed Secondary Cases			Undiagnosed Secondary Cases		
	Primary Case at Home	Primary Case at Hospital	Totals	Primary Case at Home	Primary Case at Hospital	Totals
Diagnosed cases (within one week)	54	45	99	6	5	11
Undiagnosed cases, later diagnosed	36	5	41	6	..	6
Undiagnosed, primary cases	42	..	42	3	..	3
Undiagnosed, secondary cases	2	1	3	3	..	3
Probable carriers	28	5	33	8	2	10
Intermediate illness:						
—with hemolytic streptococci	2	5	7	2	..	2
—no hemolytic streptococci	2	4	6	..	..	..
—not cultured	2	..	2	1	..	1
Convalescent carriers	11	22	33	6	2	8
Totals	179	87	266	35	9	44

secondary cases are thought to have originated from such persons. Three-fifths of those investigated were found to harbor hemolytic streptococci in the upper respiratory tract. The third group of carriers disseminated the infection after release from isolation; convalescent carriers. Transmission of infection was of this nature in 41 instances. Hemolytic streptococci were demonstrated in some member of about one-half of the families when the secondary case was supposed to have originated from a carrier.

Still another part of the secondary infections originated from cases of scarlet fever not discovered until a second person developed the disease. Thirty of these original cases were then reported as scarlet fever; 41 never were. Of the secondary cases they caused, 83 were reported and 9 were not. It is difficult to classify secondary cases of this origin as representing case to case transmission or infection by carriers. Arbitrarily, if the secondary case occurred within 1 week of the original illness it has been listed as due to contact with a case; and if the interval was longer, as arising from a convalescent carrier. Recognizing the inexactness which must enter into such an arbitrary division, 40 of this group of secondary cases have been attributed to the acute infection of scarlet fever, and 52 to the agency of carriers, either healthy or convalescent.

Distributing all secondary infections according to isolation of the primary case at home or in the hospital, 102 cases secondary to patients isolated at home are considered as due to infection from a case, and 112 to carriers. For hospital cases the distribution is somewhat different in that 43 were of carrier origin and 53 from cases.

Scarlet fever in general is considered a disease largely arising from intermediate carriers, providing unknown sources are included as carriers. There is no reason to doubt this opinion from our experience but certainly in this problem of secondary cases among familial contacts, case to case transmission is an equally important consideration. This is true whether the patient was isolated at home or in the hospital.

REACTION OF CONTACTS TO THE INFECTION

Previous discussion has been concerned with the nature of the original infection in families where scarlet fever appeared and the means by which it gained entrance into the family. Attention is now directed to what happened thereafter, the reactions of the contacts to the infection. As indicated, a considerable number developed scarlet fever; others had scarlet fever as certainly as the first group, but the disease was not reported. They are classed as having undiagnosed scarlet fever.

A third group of people contracted sore throat which, so far as could be determined by questioning or by observation, was unattended by an eruption; and definitely, by observation, was without desquamation. A fourth group had upper respiratory infections of the general nature of common colds subsequent to the appearance of scarlet fever in the family, likewise without eruption or desquamation of the skin. The great majority of the contacts had no illness (Table V).

The number of persons who were reported as having contracted scarlet fever subsequent to an initial primary case, either diagnosed or undiagnosed, was 266, and the secondary attack rate is thus determined as 6.3 cases per 100 contacts. Seven of these persons had a history of previous scarlet fever and presumably the current illness represented a second attack. The correctness of the information about previous attacks of scarlet fever depends upon the statement of the individual. It was

TABLE V

ILLNESSES IN CONTACTS ACCORDING TO AGE, AND HISTORY OF PREVIOUS SCARLET FEVER

	Previous Scarlet Fever			No Previous Scarlet Fever			History Unknown			Totals
Age:	0-14 yr.	15 + yr.	Totals	0-14 yr.	15 + yr.	Totals	0-14 yr.	15 + yr.	Totals	All Cases
Diagnosed scarlet fever	1	6	7	162	43	205	42	12	54	266
Undiagnosed scarlet fever	2		2	37	5	42				44
Tonsillitis	22	54	76	165	121	286	4	13	17	379
Upper respiratory infection	27	18	45	151	57	208	2	10	12	265
No illness	111	609	720	705	1,601	2,306	15	255	270	3,296
Totals	163	687	850	1,220	1,827	3,047	63	290	353	4,250

FREQUENCY PER 100 CONTACTS

	Previous Scarlet Fever			No Previous Scarlet Fever			History Unknown			Totals
Age:	0-14 yr.	15 + yr.	Totals	0-14 yr.	15 + yr.	Totals	0-14 yr.	15 + yr.	Totals	All Cases
Diagnosed scarlet fever	0.6	0.9	0.8	13.3	2.4	6.7	66.7	4.1	15.3	6.3
Undiagnosed scarlet fever	1.2		0.2	3.0	0.3	1.4				1.0
Tonsillitis	13.5	7.9	8.9	13.5	6.6	9.4	6.3	4.5	4.8	8.9
Upper respiratory infection	16.6	2.6	5.3	12.4	3.1	6.8	3.2	3.4	3.4	6.2
No illness	68.1	88.6	84.7	57.8	87.6	75.7	23.8	87.9	76.5	77.6

not always possible to verify this, because of residence in another city at the time, failure to remember the date, or other factors. One of the 7 persons was a child, of 163 children previously stated to have had scarlet fever. Of 687 adults with a history of previous scarlet fever, 6 had attacks in the course of these observations. The attack rates are essentially the same for both children and adults with a previous history of the disease (respectively 0.6 and 0.9 per cent). For those who presumably had not had scarlet fever the attack rate was 13.3 per 100 children and for adults 2.4. The differences are significant and indicate the general reliability of histories. In this connection, it may be noted that for primary cases of this series, 18 gave a history of previous attack (1.6 per cent), almost twice the proportion observed for secondary cases—17 were children. Even with allowance for inaccuracy of histories, second attacks of scarlet fever are seemingly more frequent than commonly supposed.

The rate for undiagnosed scarlet fever was for children 3.0 per cent and for adults 0.3. In the 2 instances with a history of previous attack the attending physician stated that if he had not seen the child previously with the same illness he would certainly have called the present illness scarlet fever.

Combining both diagnosed and undiagnosed scarlet fever infections, the secondary attack rate for children with previous history of the disease was 1.8 per cent and for adults 0.9 per cent. For those without knowledge of previous scarlet fever the rates were 16.3 for children and 2.6 for adults. The total secondary case rate was 7.3 per cent.

A not inconsiderable number of exposed contacts had upper respiratory infections subsequent to the appearance of scarlet fever in the family. There is no really significant difference between the number of such infections that developed among persons with a history of previous scarlet fever, and among those who had not had the disease. These infections were more commonly accompanied by hemolytic

streptococcus invasion than not; also the proportion of those with hemolytic streptococci in cultures from the nose and throat was greater in the group who had had scarlet fever. The number in the latter group who contracted scarlet fever was naturally smaller. With less rigid requirements for determination of undiagnosed scarlet fever, some of these infections on purely clinical grounds would have been so classified.

Information concerning immunity to scarlet fever as judged by the Dick test, is available for a considerable proportion of the contacts in this series. The technic of making the tests was that commonly employed. Particular attention was directed to preparation of syringes and needles, in order to avoid emphasized sources of error. The material for the test was supplied by the State Department of Health Laboratories. The tests were read after 22 to 26 hours, with results of positive and questionable tests recorded by actual measurement of the involved area of skin. Data presented in Table VI are limited to tests performed shortly after the entrance of scarlet fever into the family, with the further provision that the contact had had no recent ante-

TABLE VI

ILLNESSES IN INDIVIDUALS EXPOSED TO SCARLET FEVER, ACCORDING TO REACTION TO DICK TEST AND HISTORY OF PREVIOUS SCARLET FEVER

	0 – 14 years					
	Dick Positive			Dick Negative		
	Previous Scarlet Fever	No Previous Scarlet Fever	History Unknown	Previous Scarlet Fever	No Previous Scarlet Fever	History Unknown
Diagnosed scarlet fever	1	51	..	..	6	1
Undiagnosed scarlet fever	..	13	..	..	1	..
Tonsillitis	1	40	1	1	12	..
Upper respiratory infection	1	55	..	3	11	..
No illness	11	239	2	23	88	..
Totals	14	398	3	27	118	1

	15 + years					
	Dick Positive			Dick Negative		
	Previous Scarlet Fever	No Previous Scarlet Fever	History Unknown	Previous Scarlet Fever	No Previous Scarlet Fever	History Unknown
Diagnosed scarlet fever	1	6	..	..	4	1
Undiagnosed scarlet fever	..	1	..	..	2	..
Tonsillitis	5	10	2	1	16	3
Upper respiratory infection	1	2	..	5	8	1
No illness	11	107	5	146	344	46
Totals	18	126	7	152	374	51

cedent illness. Many additional tests were made, but excluded for these reasons. The Dick reaction is known for 1,289 persons who met these requirements. The group includes 561 children and 728 adults (Table VI).

Of persons with no history of having had scarlet fever, 79.7 per cent reacted positively to the Dick test for ages under 5 years; for ages 5 to 9, 79.3 per cent; for ages 10 to 14, 69.0 per cent; and for adults in excess of 15, 25.2 per cent. The attack rate for scarlet fever among persons with a known positive Dick reaction was for children 12.5 per cent and for adults 4.6 per cent. If to the group with recognized and reported scarlet fever infections there are added those who had undiagnosed scarlet fever, the attack rate for children with Dick positive reactions is 15.4 per cent and for adults, 5.3 per cent.

Twelve persons with an original negative Dick reaction contracted scarlet fever; 7 among 146 children, and 5 among 577 adults. The difference between the attack rate for persons with positive tests is pronounced. Most observers who have reported on the frequency of scarlet fever among groups who have been Dick tested, have recorded some few cases among persons who reacted negatively. Considering the age distribution and the intimacy of exposure in family groups, the number of cases among negative reactors, although somewhat more than average experience, is not excessive.

When a person had a positive Dick test and hemolytic streptococci were demonstrated in cultures from the nose or throat at the time of the original investigation, the proportion who subsequently contracted nonspecific illnesses of the tonsillitis and upper respiratory type was 17.5 per cent. Those with positive Dick tests but no demonstrated hemolytic streptococci later had illnesses of this nature in 16.0 per cent (Table VII).

IMMUNITY REACTIONS

What is the end result in regard to immunity, the aftermath of scarlet fever infection in these families? A large group of persons, 1,412, for all practical purposes can be considered to have

TABLE VII

ILLNESS IN CONTACTS EXPOSED TO SCARLET FEVER, ACCORDING TO DICK REACTIONS AND CULTURES FOR HEMOLYTIC STREPTOCOCCI

	Dick Positive						Dick Negative					
Age:	0–14 yr.			15+ yr.			0–14 yr.			15+ yr.		
Investigation culture:	+	−	N T	+	−	N T	+	−	N T	+	−	N T
Diagnosed scarlet fever	14	34	4	..	6	1	1	5	1	..	5	..
Undiagnosed scarlet fever	3	10	..	1	..	..	..	1	..	1	1	..
Tonsillitis	12	29	1	2	14	1	4	9	..	5	15	..
Upper respiratory infections	16	32	8	..	3	..	5	9	..	1	13	..
No illness	33	186	33	16	98	9	22	86	3	59	457	20
Totals	78	291	46	19	121	11	32	110	4	66	491	20

NT = Not taken

TABLE VIII

INDIVIDUALS ORIGINALLY DICK POSITIVE WHO WERE RETESTED 2 MONTHS AFTER EXPOSURE TO SCARLET FEVER

	Intermediate Illness								
	Diagnosed Scarlet Fever	Undiagnosed Scarlet Fever		Tonsillitis		Upper Respiratory Infection		None	
Hemolytic Streptococci:		+	-	+	-	+	-	+	-
Number observed	7	6	5	24	23	17	21	45	180
Number becoming negative	5	4	4	14	13	10	9	12	19
Per cent becoming negative	71.4	66.7	80.0	58.3	56.5	58.8	42.9	26.7	10.6

developed immunity to the disease through having had an attack of scarlet fever. Many others were immune before scarlet fever entered the home. Particular interest attaches to the supposedly susceptible persons who did not contract the disease. A goodly number of these initially had a positive Dick test. Not a few were found to react negatively to this test after 2 months, without having had recognized scarlet fever infection. Persons judged susceptible and subsequently contracting tonsillitis while scarlet fever was in the home, developed immunity in about 60 per cent of instances, as determined by the change from a positive to a negative Dick reaction. The number was essentially the same, whether or not hemolytic streptococci had been demonstrated at the time of the original exposure.

The proportion who became Dick negative is rather striking because, of a group of patients with known scarlet fever (18), tested under the same conditions, 72 per cent changed from a positive to a negative Dick reaction. This number is small, but the result is supported by observation of another group of more than 200 patients with scarlet fever and an initially positive Dick test; those reacting negatively when tested shortly after the appearance of the eruption being excluded.

The number of Dick positive reactors who became negative after having had an upper respiratory infection was slightly less, 50 per cent. If streptococci were demonstrated when first exposed, or during the illness, the proportion which became Dick negative was almost as great as for persons with actual scarlet fever. When streptococci were not demonstrated the Dick test became negative in 43 per cent (Table VIII).

Especial interest attaches to those who had no illness whatsoever during the time that a patient with scarlet fever was in the home. Nevertheless, 14 per cent had a change from a positive to a negative Dick reaction. When hemolytic streptococci were demonstrated, 26.7 per cent became negative to the test; in the larger group where hemolytic streptococci were not demonstrated, 10.6 per cent. These observations are significant in support of the

theory of latent immunization, a belief largely based upon epidemiological behavior of disease and not actual proof of immunity relationships before and after exposure. This evidence contributes to a quantitative evaluation of the phenomenon; the effect that can be expected from a relatively intimate exposure.

Information is not at hand concerning the permanency of this change from a positive to a negative reaction. Some few found to be negative 2 months after the original exposure are known to have become positive again, by retests made 2 years later. In Table VI it was shown that persons who gave a history of previous scarlet fever did not always have negative Dick tests; 32 of 211 were positive. It is known that not all patients convalescent from scarlet fever have developed a negative Dick reaction when tested at the end of 30 days. Various observers have noted persistent positive Dick reactions under such conditions varying from 5 to 40 per cent. It is quite possible that a Dick test, which has been negative shortly after scarlet fever, may again become positive as immunity varies from time to time. That is known to happen after active immunization by scarlet fever toxin. The same phenomenon may be concerned in these infections, and the test of whether or not permanent immunity actually developed will be found in the further history of these children in regard to scarlet fever.

SUMMARY

An urban population of 5,352 individuals, comprising 1,097 families invaded by endemic scarlet fever, had a secondary attack rate of 7.3 per cent. This includes diagnosed and undiagnosed cases.

Presumptive evidence is presented to indicate that many times scarlet fever first appears in the home as a simple upper respiratory infection, presumably in an immune or partially immune person, from whom the infection is transmitted in the form of classical scarlet fever to a non-immune individual.

Failure to recognize scarlet fever when first it appears in families contributes distinctly to an increased secondary case rate. The function of the undiagnosed case in transmission of the infection is important; 31.6 per cent of secondary cases were due to that cause.

There is excellent support for the belief that in general scarlet fever is a disease largely transmitted by carriers rather than by cases. This, however, is not true of familial scarlet fever, because as many secondary cases were found to arise from exposure to the acute infection as from contact with healthy or convalescent carriers.

Upper respiratory infections including tonsillitis are relatively prevalent among persons recently exposed to scarlet fever.

Evidence is introduced that many of these infections are associated with a developing immunity to scarlet fever, judged by the Dick reaction. This occurred in the present experience to an extent comparable to that with clinical scarlet fever.

Latent or sub-clinical infection was the probable explanation of the immunity which developed in 14.8 per cent of contacts to patients with scarlet fever. This occurred more commonly when hemolytic streptococci were demonstrated in cultures from the nose and throat. Indication is given of its relative importance in establishing the progressive increase in immunity known to occur with advancing age and without disease.

An attempt has been made to evaluate quantitatively the relative importance of case to case infection, missed cases, larval infections, and carriers in the transmission of scarlet fever.

From the standpoint of public health

administration, 3 things can be emphasized. Need exists for earlier recognition and isolation of cases. Too many secondary infections arise from this deficiency. When secondary cases occur in families, the interval is usually short. This substantiates the recent emphasis on a shorter period of isolation as being equally effective. In sharp outbreaks of scarlet fever, measures should be developed for the brief restriction of persons, particularly familial contacts, who have sore throat or other infections of the upper respiratory tract.

Soviet Plans Medical Zoo

A MAMMOTH zoölogical garden whose inhabitants will annually be sacrificed to the cause of science at the rate of 9,000 dogs, 7,000 cats, 21,000 rabbits, and 16,000 porpoises will be only one feature of the new medical center which the Soviet plans to start building on the outskirts of Moscow this coming spring, according to a dispatch from Moscow to *New York Sun*.

According to plans this will be the medical center of medical centers, and will automatically bring the Soviet Union to the front in the field of experimental medicine. The entire layout will cover about 1,000 acres, comprising separate but coördinated institutes devoted to research in morphology, physiology, psychology, biophysics, biochemistry, and pathology.

The headquarters building will contain a library of 600,000 volumes and an auditorium seating 1,500 people. A clinic will contain 600 beds and there will be almost one laboratory for every patient, allowing the maximum amount of attention to each case. Apart from the laboratories and clinic will be a section of apartment buildings to accommodate 12,000 people including 5,500 doctors, research workers, and nurses.

One of the ultra-modern features of the center will be a laboratory in which healthy patients may be subjected to the atmospheric conditions of various climates, ranging from the arctic to the subtropics, while doctors study their reactions. Thus it will be possible to determine, theoretically at least, what diets are best in various climates for people engaged in various activities.

In the "clinic of healthy and sick man" scientists will determine the effect upon people in various states of health of working, eating, and sleeping.

Before drawing up plans for this ambitious center the All Union Institute of Experimental Medicine sent a commission to the United States to study the work of the medical centers at Cornell and Columbia and the Rockefeller Institute, and it is probable that a representative of the New York city health commission will visit Moscow next spring to give consultation.

While the Soviet Union is still greatly handicapped in the field of practical medicine by lack of capable physicians and of medical supplies this condition has not been allowed to retard progress in the province of experimental medicine.

The plans of the Soviet for the development of the system of "state medicine" are almost limitless and the new medical center will form an indispensable part of the system.

The buildings and the equipment, some of which may be bought in the United States, will cost about 150,000,000 rubles. The center should be in full operation by 1939.—*New York State J. Med.* 35, 4:156 (Feb. 15), 1935.